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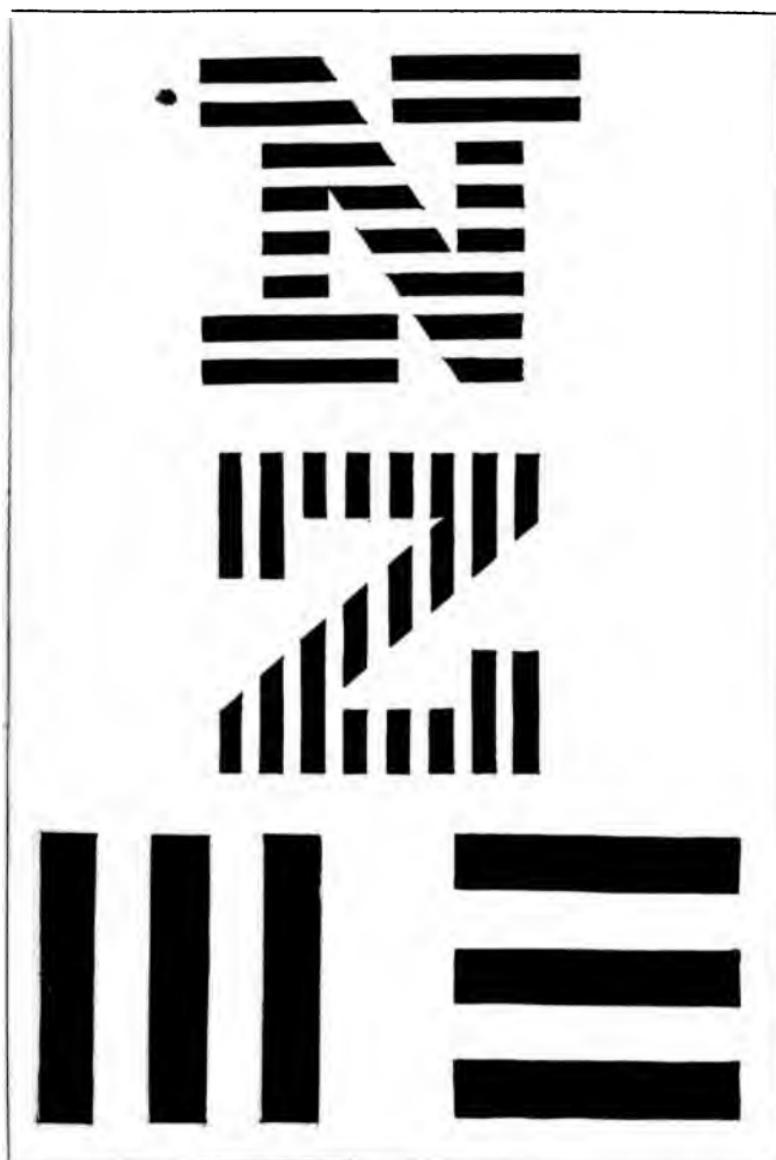
THE SIGHT
AND HOW
TO PRESERVE IT

ANGELL









TESTS FOR PECULIAR SIGHT (Astigmatism).

(See page 39.)

THE SIGHT, AND HOW TO PRESERVE IT.

BY

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'A TREATISE ON DISEASES OF THE EYE,' &c., &c.



LONDON:
HARDWICKE AND BOGUE, 192, PICCADILLY, W.
1878.

151 . o . 460 .

PRINTED BY W. CLOWES AND SONS, STAMFORD STREET AND CHARING CROSS.

P R E F A C E.

THOUGH not the first work of the kind published, this is believed to be simpler, freer from technical terms, and shorter than its predecessors. These merits, it is hoped, may render it exceptionally popular, and therefore exceptionally useful.

The growing prevalence of weak sight in this country, both in children and adults, would seem to make a wider knowledge of the eye, and how to take care of it, of some importance.

CONTENTS.

	PAGE
HOW WE SEE..	8
ACCOMMODATIVE OR ADJUSTING POWER OF THE EYES ..	12
CONVERGENCE OF THE EYES	13
RELIEF OF WEAK SIGHT (ASTHENOPIA)	14
OVER-SIGHT	20
EYE-GLASSES FOR OVER-SIGHT	27
NEAR-SIGHT (MYOPIA)..	28
SELECTION OF GLASSES FOR NEAR-SIGHT	32
OLD SIGHT	33
PECULIAR SIGHT (ASTIGMATISM)	39
SPECTACLES AND EYE-GLASSES	41
COLOUR-BLINDNESS	42
CONTAGIOUS DISEASE OF THE EYES	43
ACCIDENTS TO THE EYES	43
SYMPATHETIC DISEASE OF THE EYES	46
ARTIFICIAL EYES	46
BABIES' SORE EYES	47
CATARACT IN CHILDREN'S EYES	47
SQUINT OR CROSS-EYE	50
PROGRESSIVE NEAR-SIGHT IN CHILDREN	50
ACQUIRED NEAR-SIGHT IN CHILDREN	52
NEAR-SIGHT IN CHILDREN A DISEASE	54
DEFECTS OF SCHOOL-ROOMS	56
WHAT TO DO FOR NEAR-SIGHT IN CHILDREN	58
IMPERFECTION OF THE EYE AS AN OPTICAL INSTRUMENT	59
TEST-TYPE	22, 24, 51, 63

THE SIGHT,

AND

HOW TO PRESERVE IT.

SOME KNOWLEDGE OF THE EYE NECESSARY FOR ITS PROPER CARE.

TO take proper care of our eyes is to do what we can to avoid such diseases or weakness of the eyes as are avoidable. But to do this efficiently we must know something about the eye and its diseases and weaknesses. We must know what certain feelings about the eyes mean, what pain and fatigue mean, and why the eye is so often subject to fatigue and pain. We cannot afford to give up the entire use of our eyes because they ache, nor can we afford wholly to disregard ominous symptoms lest we run the risk of impairing sight or losing it. We wish to use our eyes, to preserve our sight to the last, and to avoid all avoidable disease.

THE SYMPTOMS OF WEAK SIGHT (ASTHENOPIA).

The first symptom is fatigue of the eyes during or after reading, writing, sewing, and similar work in the evening. Very soon the same fatigue is noticed after like occupations during the day, when the light is good. After a time, fatigue of the eyes comes on immediately on attempting to read or sew, and, if disregarded, pain and confusion of vision follow. Letters appear to run together, lines are blurred and indistinct, and continued use of the eyes in reading becomes impossible. If we then look up, across the room, or in the distance, quick relief comes, and vision is as clear and distinct as possible; but an attempt to read again brings a return of pain and confusion of sight.

HOW WE SEE.

In order that we may comprehend exactly the nature of weak sight, let us consider for a moment the structure of the eyes and how we see. The figure numbered A, on the next page, gives an idea of the anatomy of the eye, sufficiently full for our purpose. The rays of light from an object enter the eye through the pupil (P), and, passing back to the inner coat of the eye, the retina (R), form an image of the object upon it very much as an image is formed on the plate in the camera

FIG. A.

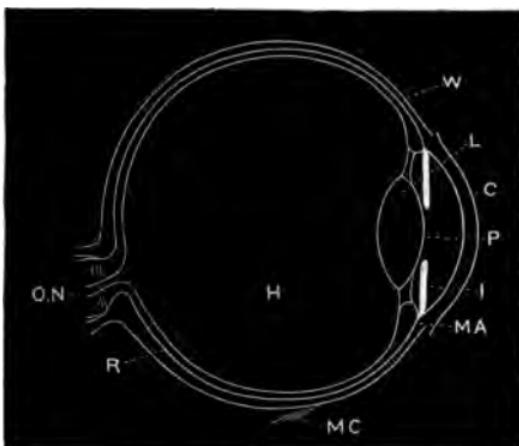


Fig. A gives a profile view of the eye ; that is, the eye-ball is divided into two equal parts, just as one might divide an apple or an orange, and the flat, cut surface held up to view.

W points out the white of the eye, a strong protective coat extending quite around the eye-ball except in front. It is called the *sclerotic coat*.

C, the *cornea*, or transparent front of the eye ; and, behind it, I, the *iris*, or coloured part of the eye, extending in a circle around. P, the *pupil*, which is a circular hole in the iris, that admits the light into the eye, and out of which the eye sees.

L is the crystalline *lens* directly behind the pupil. In health, the lens is transparent like the front of the eye, and offers no obstruction to the passage of rays of light ; but if it becomes opaque, it is called *cataract*, and the eye is more or less blind from the obstruction of the passage of light.

MA is a little muscle, called the *muscle of accommodation*, that adjusts the focus of the lens and the eye for near objects.

MC is a muscle attached to the white of the eye on the outside, that converges or turns the eyes inward, and is the *muscle of convergence*.

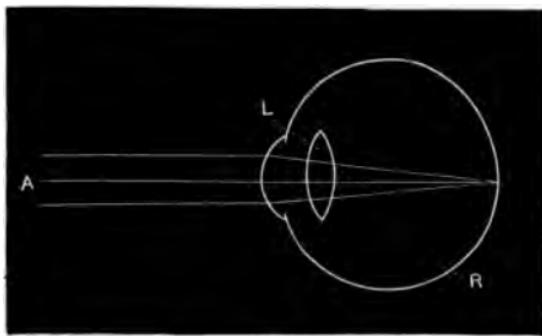
R points to the inner lining of the eye, the *retina*, upon which images of objects are pictured ; and

ON is the *optic nerve* that conveys these pictures to the brain.

H is the body of the interior of the eye, filled by a transparent *humour*.

of the photographer. Indeed, quite lately, experiments have been made that show a very close relation between the nature of photography and the nature of the process that goes on in the act of seeing. Rabbits have been held a few seconds before a window, and then, being immediately killed, the picture of the window has been found distinctly photographed on the retina of their eyes. After the reception of the image upon the retina, the act of seeing is completed by the transmission of the impression to the brain through the optic

FIG. B.



A, the rays of light entering the eye.

R, the retina, where they should be focussed.

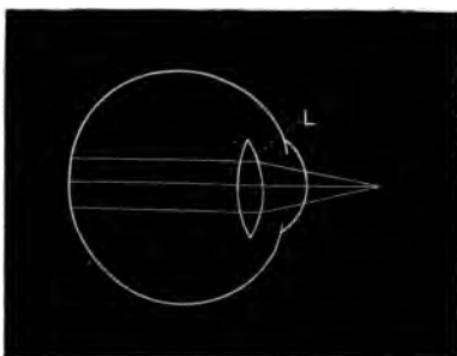
L, the lens by which the rays of light are chiefly focussed.

nerve (O N in the figure). But in order that the image of an object on the retina shall be clear and distinct, it is necessary that the rays of light passing *into the eye through the pupil* should be properly *focussed*. See Fig. B.

Vision will be clearest and easiest if the rays of light are brought to a point exactly as they reach the retina. If they are focussed just before, or if they reach the retina before being focussed, the sight will be more or less blurred.

When we are looking at a distance, if our eyes are neither near-sighted nor far-sighted (over-

FIG. C.



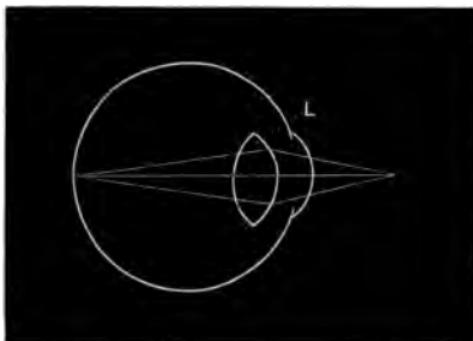
sighted), the rays of light that enter the eye are focussed on the retina, as seen in Fig. B, without effort on our part; but if we regard near objects, as in reading or sewing, there is an effort of the eye to focus the rays of light: otherwise they would reach the back of the eye without being brought to a point at all, as seen in the figure above.

The reason of this is that rays of light from small objects—as in letters, for example—approach the eye, not in parallel lines, as seen in Fig. B, but in lines that diverge as they pass into the

eye, as seen in Fig. C. To converge such lines to a point on the retina requires more focussing power than if they entered the eye in parallel lines, as seen in Fig. B. This focussing power, which is called

THE ACCOMMODATIVE POWER OF THE EYE, is furnished by a muscle (M A, Fig. A). This muscle we may call the muscle of accommodation, and when it is brought into use, the lens (L in the figures) is made more convex or full, and thus a greater focal power is given to the eye. The fuller or more convex the lens, whether the natural one

FIG. D.



within the eye or a glass lens such as used in spectacles, the greater its power of bending rays of light to a point. Notice that the lens (L) is more full in Fig. D than in Fig. C.

If we look at distant objects the muscle relaxes,

because the use of the accommodative power is unnecessary ; but always, in reading, writing, sewing, and every kind of occupation requiring fixation of sight on near objects, this accommodative apparatus is brought into use. Though involuntary, the accommodation or adjustment of the eyes for near objects is an effort ; hence the relief that comes from looking up and off from near work, so especially grateful to fatigued and sensitive eyes.

CONVERGENCE OF THE EYES.

Another factor in the act of adjustment of the eyes for near objects is convergence. By this is meant the turning inward of the eyes so that both may be directed to the same object. If you will hold up a finger before the face, at a distance of four or five inches from it, and look at it fixedly with both eyes, you will notice that a distinct effort is made to turn the eyes inward ; and if you continue to look at the finger in this position, the act will soon become painful. The convergence of the eyes is also an effort, and is brought about by a muscle on the outside of each eye-ball, attached to the white of the eye on the side towards the nose. This muscle (M C, Fig. A) we may call the muscle of convergence. There are other muscles which modify the action of this one, but they need not be considered here.

THE NATURE OF WEAK SIGHT.

Weak sight is therefore nothing more nor less than a disorder of the accommodative apparatus : or, we may say, a disorder of the two muscles of accommodation and convergence. In health, these two muscles work together in perfect harmony. If either one becomes affected, this harmony is disturbed, and weak or painful sight may follow ; but the immediate occasion, usually, of weak sight is an overworked, fatigued, sensitive condition of these muscles. It is plain, then, that as in distant vision this muscular apparatus is not used, and as in near work it must of necessity be brought into service, if sight is weak and painful and we wish to improve and cure it, we must carefully regulate the way in which we use our eyes, with a view to relief of this overused and weakened adjusting power.

HOW TO RELIEVE OR PREVENT WEAK SIGHT.

Persons having a tendency to weakness of sight, or those experiencing unusual fatigue of the eyes in reading, or similar occupation requiring close vision, should carefully observe the following rules :

1. Cease to use the eyes for the time being, and look away from the work, when sight becomes in the least painful, blurred, or indistinct. After perfect rest for a moment, or longer, work may be

resumed, to be discontinued as before when the eyes feel again fatigued.

2. See that the light is sufficient, and that it falls properly upon your work. Never sit facing it. It is best that the light should fall upon the work from above and behind. Failing this, it may fall from the side. Never use the eyes at twilight. Any artificial light for the evening is good if it is brilliant enough and steady. A flickering gas-light is injurious. The argand gas-burner with a chimney does not flicker, is brilliant, and may therefore be recommended. A study-lamp, or any lamp with a chimney, burning oil or kerosene, if it affords a sufficiently brilliant light, may also be agreeable for the eyes. When artificial light is at all painful, it is safer to read or write only during the day.

3. Never read in railway trains or omnibuses. It requires too great an exertion of the accommodative power to keep the eyes accurately focussed and fixed on the letters. Business men are in the habit of reading the evening papers on their way out of the City, and the morning papers on their way in. This dangerous practice is rather a frequent cause of weakness of sight. There are those who can follow it with impunity year after year (see p. 41), but there are more who cannot.

4. Never read when lying down: it is too

fatiguing for the accommodative power. Many a tedious case of weak sight has been traced to the pernicious habit of reading in bed after retiring for the night.

5. Do not read much during convalescence from illness. Before the muscular system generally has quite recovered its healthy tone, we ought not to expect the muscles of accommodation to bear the continuous use to which they are subjected in reading or writing. We cannot be sure that the delicate muscles of the eye are in a condition to be used until the muscles of the leg and the arm have regained their strength and firmness.

6. The general health should be maintained by a good diet, sufficient sleep, air, exercise, amusement, and a proper restriction of the hours of hard work. One ought not to expect strong eyes in a body weakened by bad habits or an injudicious amount of labour. Bright gas-lights in crowded rooms, and the impurity of the air in such places, are especially to be avoided. Medical advice should be sought in regard to any nervous debility, disorder of the organs of digestion, or any functional disturbances of a general nature, whether they appear to have a direct connection with the weakness of sight or not.

7. Take plenty of sleep. Sleep is a sovereign balm for those who suffer from weak sight. Retire

early and avoid the painful evening lights. Ten hours' sleep for delicate eyes is better than eight.

THE USE OF EYE-GLASSES IN WEAK SIGHT.

If the weak sight does not improve satisfactorily under the observance of the rules given, it will be necessary to resort to the use of convex glasses. It is better in this case to consult a competent oculist. He will furnish you a recipe, which may be taken to a good optician, who will sell you the glasses prescribed. The eye-glasses are to be used exactly as directed by the oculist. For the benefit of such as are unable to get proper advice, it may be well to say that the convex glasses will probably require to be of about 48-inch focus, and that they are to be worn only in reading, sewing, and such occupations as require the accommodative apparatus of the eye to be brought into use. The moment the eye tires, the glasses must be removed; to be replaced again, after a rest of the eyes, when work is resumed.

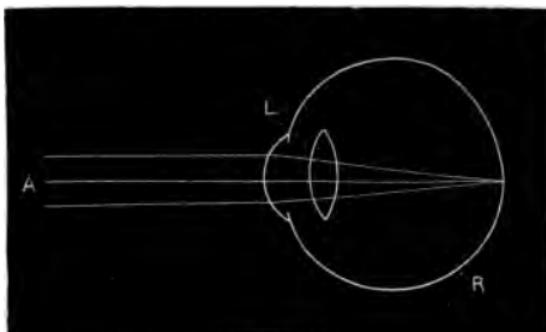
To accustom the eyes to the help of glasses may require some days or weeks and considerable patience. After beginning with them, it is best not to omit their use in reading or sewing, even temporarily, but to work or read always by their help; limiting the amount of reading at first, and

then increasing it day by day, or week by week, until the sight becomes strong.

WHY CONVEX GLASSES ARE USEFUL IN WEAK SIGHT.

By looking at the figure below, you will see that parallel rays of light, or rays of light from a distance, are focussed exactly on the retina at the back of the eye (Fig. B). But divergent rays from near

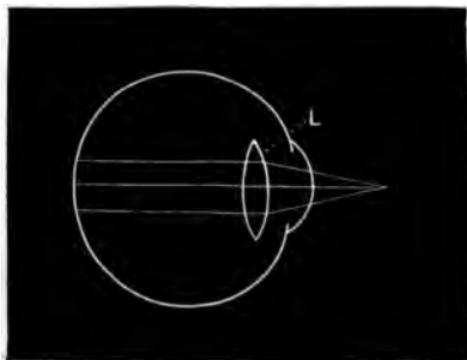
FIG. B.



objects, as seen in Fig. C, are not focussed properly. Next, you will observe that in Fig. D the rays of light are there again brought to a focus by means of the muscular adjusting power, or what we call the accommodative power. Notice in this figure that the lens (L) is more convex or full than in the other figures. This gives the eye a greater focal power; just exactly what it needs in looking at

fine objects quite near it. Now if we put convex glasses () before the eyes, it renders them practically more round and full, so that rays of light are focussed without calling upon the weak and fatigued

FIG. C.



adjusting apparatus for help. It gives us a chance to use the eyes without fatigue.

WHAT RESULTS IF NO ATTENTION IS PAID TO THE WEAK SIGHT.

If the symptoms of pain, confusion of vision, dread of light and of all use of the eyes continue, and no measures are taken to ameliorate or remove them, there is danger of the eyes not only becoming nearly useless, but that they may finally get so sensitive and irritable that ordinary daylight cannot be borne without pain and discomfort. When weak sight has been allowed to progress for years,

it sometimes becomes so severe that one finds a darkened room the only really comfortable place, dark-blue or smoke-coloured glasses not affording a sufficient protection from the light. I recall a patient several years ago, whose eyes had become so sensitive that he came to me wearing two pairs of glasses,—dark-green goggles and dark-brown spectacles,—and these made it so dark that he could scarcely find his way about. I remember also his saying that if he raised his glasses at a street-crossing, to enable him to avoid passing vehicles, he would be obliged to spend two hours in a dark room to quiet the pain and discomfort. This was, of course, an exceptionally severe case. His eyesight was still preserved, but it was almost worse than useless to him.

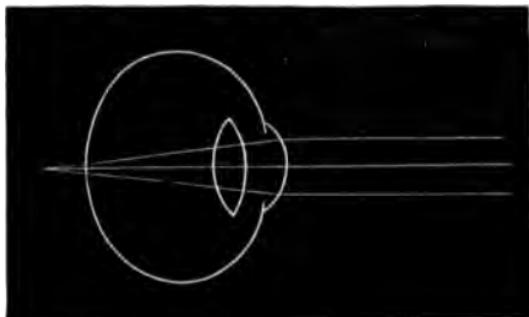
Severe cases of weak sight are tedious and difficult to cure, and particularly so if of years' standing ; but recent cases are curable.

OVER-SIGHT OR FAR-SIGHT.

This is a defect of a nature exactly the opposite of near-sight. In near-sight, the eye is adjusted or accommodated for a point nearer than the object looked at, and consequently does not see distant things distinctly. In over-sight, it is fixed for a point beyond the object looked at, and does not see well either near or far. In near-sight, the eye-

ball is too full or convex, and in over-sight it is too flat. Being too flat, the rays of light entering the

FIG. E.



pupil reach the retina at the back before being focussed, as represented in Fig. E, and therefore vision is blurred and indistinct.

FIG. F.

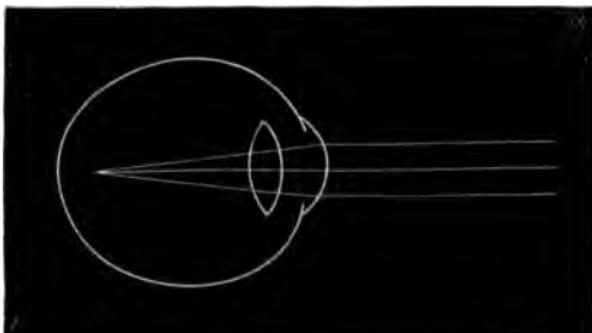


Fig. F shows a profile view of a near-sighted eye. Here the rays of light are seen to come to

a focus before reaching the retina, because the eye-ball is too full or too long from front to rear (Fig. F, p. 21).

HOW TO DETERMINE WHEN ONE IS OVER-SIGHTED.

In over-sight one does not see with perfect clearness and ease at any distance. Very fine type like this, for instance, is not read, even by those too young to be old-sighted, in a good light, quickly, fluently, and without effort.

A parting visit to the Alhambra, and a call on our banker, and we were ready and eager to climb over the great mountains to Malaga and the Mediterranean. The banking-house was found to be a grocery also, and the polite clerk invited us to come the next day to see his master. On the following day the banker himself inspected our letter of credit, and then, with expressions of regret at our impatience, appointed an hour on the morrow to hand us the money. The hour of twelve on the succeeding day found us promptly at his counter, where, to our dismay, we found a large heap of silver dollars awaiting us. As usual, the banker was away, and the clerk had no authority to give us gold or paper instead ; so we told him that we would, therefore, only draw enough upon our letter of credit to take us to Malaga, whereupon he at once scraped away his heap of silver and handed us its equivalent in gold. We left Granada that afternoon at six o'clock in the *berlina* of an excellent diligence drawn by four real horses that did not degenerate into five mules and a boy until we arrived at Loja. The journey along the great intervals called the Vega, towards this place, is picturesque and full to the brim of the bewitching Moorish romance that makes so captivating a part of every thing in this ideal region. On our left, high above us, lay the snow-capped Alpujarras, the last mountain refuge of the unhappy Moors, and near it the peaks that look down upon the site of the romantic fortress of the Alhama. In front the great gorge through which the river Xenil finds its way among the mountains to join the Guadalquivir, at the right the rough hills, beyond which is old Cordova and its famous Mosque ; behind us, beautiful Granada, its slender spires and turrets, its shadowy red hill crowned by the great Moorish palace. It was our parting look ; the growing twilight and a rising veil of mist that half concealed the charming scene, lent a fervour to the imagination inseparable from such a moment.

A half hour later and our diligence stopped to take up a native soldier who, to our dismay, got into the *berlina* and sat between us, although there was plenty of room behind in the interior. As a matter of course we expected him to smell of garlic, like everybody and everything else in Spain. Our mistake was in supposing that the redundancy of smell in this case could be made supportable by violent use of cigarillos and extraordinary ventilation. He was an inoffensive good-natured fellow, and did not mind the cool night winds ; but when he took up his little tin-pail of lunch and pulled off the cover, giving free vent to the imponderable garlic, it was very hard for us not to believe him conscious of having, most impolitely, vivified our common atmosphere.

Nor are street signs made out as easily as by others with properly formed eyes. The attempt to tell the time by a public clock at a distance is

not quite satisfactory, although in regard to distant objects the sight is far better than that of a near-sighted person. If an over-sighted person tries the test-type numbered 5, 6, 8, 10, 12, 14, on the next page, each of which lines of letters should be seen at a distance in feet corresponding to its number (thus, 6 should be held at six feet, 12 at twelve feet, and 14 at fourteen feet away), he will find that the letters are not easily distinguished at the proper distance. Number 50 and number 20, on page 25, may not be seen distinctly at fifty and twenty feet. If he looks through very weak convex glasses, of 60 or 72 inches focus, the vision for distance will be improved. And the fine print on page 22 will be read more easily,—the print will be blacker,—by putting on convex glasses of 40 or 48 inches focus. When there is a doubt as to the existence of over-sight, or a doubt as to the particular nature of defective vision, it is well to consult an oculist, and have the eyes examined with the view to determine exactly the existing visual weakness.

OVER-SIGHT A COMMON CAUSE OF WEAK SIGHT.

We have seen on page 14 that weak sight is the result of overworking the muscles of accommodation and convergence. Now, as seen in Fig. E, an over-sighted eye is so flat or shallow that rays of

No. 5.

G T O H L E Q F D

No. 6.

H G E D P U O I E

No. 8.

I G O T C L E I U

No. 10.

U F T D H G P O E

No. 12.

Q E C P U F D I L

No. 14.

P D L F H O T G I

No. 20.

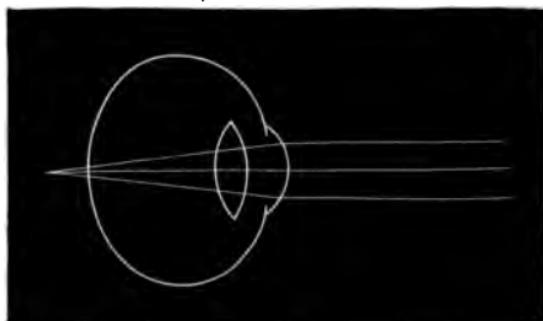
F P L O H

No. 50.

U C P

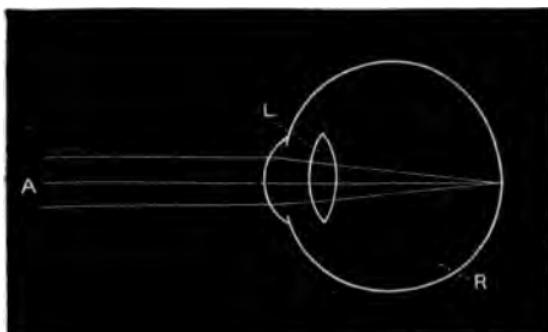
light reach the back of it before being focussed ; it is therefore clear that such an eye must be continually using its accommodative power in order

FIG. E.



to see at all. It is to be remembered that an eye of correct form does not need to call into use the

FIG. B.

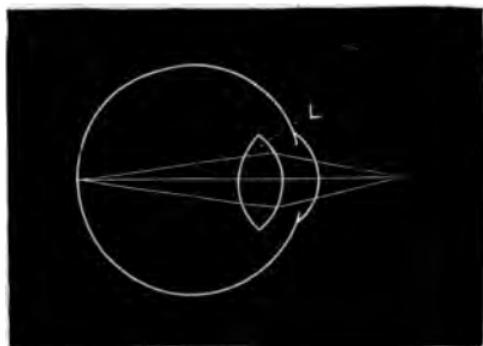


muscles controlling its extra focussing power when regarding distant objects (see Fig. B), but only when regarding near objects ; as in reading, writing,

and like occupations, as shown in Fig. D, where the lens is noticeably more full or convex.

As an over-sighted eye must continually exert itself at all distances to focus rays of light, it is almost certain to overuse its accommodative power; and therefore over-sight is a very usual cause of weak sight. An eye correctly formed may become weak-sighted; but an eye that is too flat is, if put to much near use, almost sure to get fatigued, and

FIG. D.



in time to develop all the unpleasant features of this affection. Having to use its accommodative power for distant as well as for near objects, there is no rest for it except during the hours of sleep.

CONVEX GLASSES FOR OVER-SIGHT.

The remedy for over-sight suggests itself at once. If the eye is too flat, of course a convex glass ()

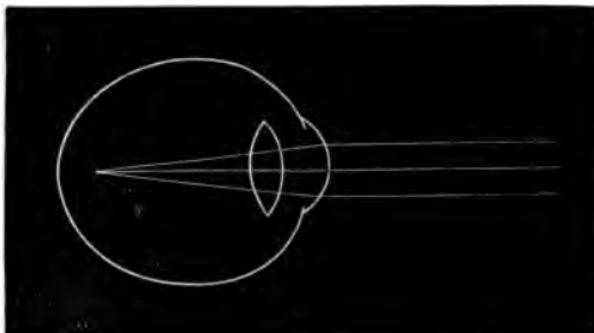
makes it less so, practically, and thus removes the effect of its defective form. Convex glasses in the form of eye-glasses or spectacles are therefore imperative to prevent the development of weak sight as well as to aid vision. What the strength of the glasses should be will depend upon the degree of faulty formation of the eye-ball. An oculist is the proper person to determine this. My object here is to make the fact clear that no method of resting the eyes, and no kinds of rules and regulations, can probably prevent such eyes becoming weak-sighted, painful, and useless, except convex glasses be worn; and that these will, to a great extent, render such eyes serviceable and comfortable. Those who are over-sighted, are, however, advised to use their eyes with discretion, and to regard the rules and regulations given on pages 14-17.

NEAR-SIGHT (MYOPIA).

This is defective sight of a nature exactly the opposite of that of over-sight. The eye is too full, or too deep from front to rear, so that the rays of light are brought to a focus before reaching the retina, at the back of the eye (see Fig. F). Vision is, therefore, indistinct and hazy unless objects are brought very near. It will be remembered that, in order to see clearly, rays of light must be focussed

exactly on the retina; but, in a near-sighted eye, the distance between the retina at the back of the eye and the front of the eye-ball is so great, that the convex form of the lens brings the rays of light to a point, in spite of all effort to the contrary, before they reach the retina. The exercise of the accommodative or adjusting power of the eye is of

FIG. F.



no use, or even worse than useless, because, when brought into service, its function is to make the lens more convex (see p. 12); and this addition to the refractive power of the eye would, of course, focus the light still sooner, and so increase rather than help the difficulty.

THE USE OF CONCAVE GLASSES.

To render vision clear in near-sight, it is of course necessary to resort to some means by which the rays of light may be prevented from being

focussed too quickly after entering the pupil. That is, we wish to do exactly the opposite of that which we wish to do in over-sight, at page 28.

This is accomplished by putting before the eyes concave glasses)(either in the form of eye-glasses or spectacles. A concave glass is one which is hollowed out, or thinner at the centre than at the edges. A convex glass, suitable for far-sight or over-sight, is one thicker at the centre than at the edges. Such glasses help to focus the rays of light; while a concave glass, by diminishing the effect of the convex form of the eye-ball, hinders the focussing of the rays of light, and thus permits them to reach the back of the eye in proper form for good vision.

NEAR-SIGHTED EYES ARE GENERALLY DISEASED.

Near-sight is usually accompanied by a disease in the back part of the eye. This is almost always the case in the near-sight of children and youth. Besides this disease in the back part of the eye, such eyes are often weak-sighted,—the weak sight being mostly due to weakness and fatigue of the muscles of convergence (M C, Fig. A, p. 9). The muscles of convergence are very liable to be over-worked, because print in reading and fine objects of all kinds must be held quite near, which necessi-

tates a strong turning inward of the eyes. I have spoken more at length of the disease in near-sight at page 58 and the following pages, when considering the near-sight of children.

HOW TO KNOW NEAR-SIGHT.

It may seem at first, to some readers, needless to state the indications for the existence of near-sight. But in very slight cases, and in the beginning of the progressive near-sight of children, it is not always so very easy to detect. At all events, children are often brought to us for advice in affections of the eyes, the parents having no idea that near-sight is the cause until told of it. By using the test-letters at pages 24 and 25, we may determine, generally speaking, the existence of the defect. No. 20 cannot be seen at twenty feet, nor No. 50 at fifty feet. Or if it be possible, in some light cases, to see those numbers at the required distances, it can only be done with great effort and by nearly closing the eyelids, so as to allow the rays of light to enter the pupil through a small aperture. A quick and more certain mode of detecting near-sight is to put a pair of weak concave glasses before the eyes, which at once remarkably improves the vision for distance.

SELECTION OF GLASSES FOR NEAR-SIGHT.

To choose the proper concave glasses for near-sight is so difficult a matter and, considering the usually more or less diseased condition of the eye, so fraught with grave consequences as to their effect upon the organ, that I must strongly advise that their selection be entrusted to a competent oculist. Neither will a good optician—one who sells spectacles and eye-glasses—care to take the responsibility. In general terms, one may say that concave glasses for near-sight should never be too strong, lest the shape of the eye-ball is, practically, too much flattened by them. This would reduce the eye too far towards the condition of an over-sighted one, as seen at page 21, and make too great a use of the adjusting or accommodative power necessary, and this in turn tend to produce weak sight, with pain and fatigue.

Often, two pairs of spectacles or eye-glasses will be needed,—a stronger pair for distance and a weaker pair for reading. The pair for distance may be such as to permit the wearer to see letters No. 20 at twenty feet distance, or nearly twenty feet distance. Those for reading should be the weakest with which he can read the fine type on page 22 at twelve inches from the eye. Weak and painful sight in adults due to near-sight is to be relieved

by rest of the eyes, avoidance of bright evening light, use of properly fitted glasses, and a general observance of the rules given on pp. 14-17. See also the remarks on progressive myopia on p. 54 and the following pages.

OLD SIGHT.

At about the age of forty or forty-five, and sometimes perhaps rather earlier in life, we notice a desire for a good strong light in reading, or threading a needle, and a disposition to push fine reading or sewing farther away from the eyes. Then follows more or less fatigue and confusion of sight in reading and sewing in the evening, especially if tired, and it is found comfortable to favour the eyes by frequent rest and change of occupation. Very soon, a like difficulty in reading fine print is noticed in the daytime.

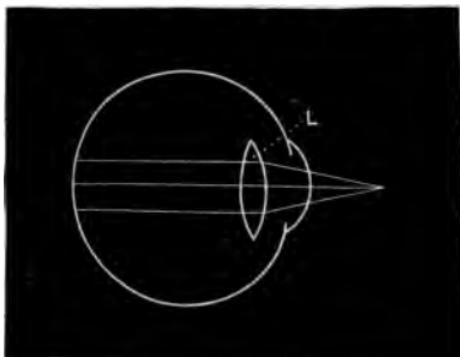
CAUSE OF OLD SIGHT.

Old sight is due to a partial loss of the accommodative power of the eye. Hence, in looking at a distance, the accommodative or adjusting power not being required, the eye sees as well, or nearly as well, as ever; but in near vision, the accommodative power being necessary and not being available vision is imperfect. The loss of the accommodative power is not from disease of the eye at all, but is owing chiefly to the natural increase of the hard-



ness of the lens and consequent loss of its elasticity. We must bear in mind that the accommodation of the eye for near work, as in reading, means the

FIG. C.

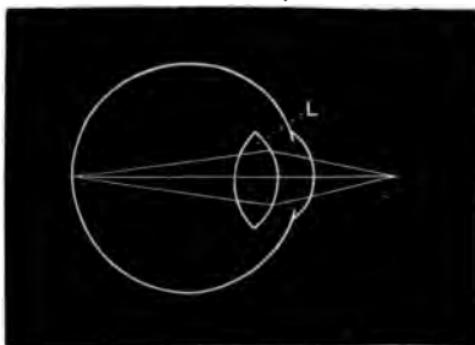


calling into action of the muscle of accommodation (M A, Fig. A, p. 9). This action results in making the lens more convex, as seen in Fig. D (p. 35). As the lens gets harder with advancing age, this change of form becomes more and more difficult.

This figure represents the lens sufficiently convex to focus the rays of light properly upon the retina. Fig. C (above) represents the condition of an old-sighted eye attempting to read without glasses. Notice that the lens (L) in this figure is nearly flat, as if the eye were fixed for distance, and the rays of light are not focussed; while in Fig. D the lens is made full or convex by the exercise of the adjusting power, so that the rays of

light are properly brought to a focus on the retina at the back of the eye.

FIG. D.



HOW CONVEX GLASSES HELP OLD SIGHT.

Now as in old sight, seen in Fig. C, the accommodative power—that is, the power of increasing the convexity of the lens and so increasing its focussing power—is partially gone, it is necessary that the focal power of the eyes should be aided by glasses. We therefore place convex glasses () before the eyes. These of course making the lens practically more convex, the loss of the adjusting power is not felt, and the rays of light are brought to a focus as in younger eyes.

SELECTION OF GLASSES FOR OLD SIGHT.

Convex glasses being the remedy for old sight, they should be sufficiently strong to enable one to

read the type on page 51 easily and fluently at a distance of ten or twelve inches. If too strong, the print must be brought nearer than ten inches to see clearly, and this will tire the muscles of convergence that turn the eyes inward. If too weak, the fine print will have to be held farther than twelve inches away, and the letters are too small to be seen easily much beyond this distance from the eyes.

The following table gives an idea of about the strength of glasses needed at different ages; but it cannot be strictly followed, as an existing near-sight or over-sight with an old sight will require weaker or stronger glasses than those indicated in the table. The numbers are given in metres as well as inches, as the metric system is now being used by oculists in prescribing, and by most manufacturers of lenses for spectacles.

AGE.	NUMBER AND FOCUS IN INCHES.	NUMBER IN METRES.
45	48 to 60 inches focus.	$\frac{2}{3}$ of a metre.
50	36 „ 40 „ „	1 „
55	24 „ 30 „ „	$1\frac{1}{2}$ „
60	18 „ 20 „ „	2 metres.
63	14 „ „ „	$2\frac{1}{2}$ „
66	12 „ „ „	3 „
70	10 „ 11 „ „	$3\frac{1}{2}$ „
74	8 $\frac{1}{2}$ „ 9 „ „	4 „
78	7 „ 8 „ „	$4\frac{1}{2}$ „
80	6 $\frac{1}{2}$ „ 7 „ „	5 „
82	6 „ 6 $\frac{1}{2}$ „ „	6 „

**WHEN TO BEGIN WEARING GLASSES FOR OLD
SIGHT.**

I have said that old sight is due to loss of accommodative power from hardening of the lens. In youth the lens is quite soft and elastic, but it grows gradually harder, until in old age it becomes as hard as wax. Old sight is therefore not a sudden affection, but one which, advancing gradually, is not noticed until it interferes with our work, and then we resort, or should resort, to glasses.

The putting on of suitable glasses should not be neglected after the early evening symptoms of old sight are noticed. Nothing is gained by waiting, and much may be lost. We lose, in the first place, a great deal of amusement and instruction from the necessity of giving up our evening reading, avoiding small print, resting our eyes, and neglecting fine work of all kinds. In the beginning, these interruptions in our ways of life are not so serious and frequent as to give much annoyance, but as old sight increases they become of importance. In the second place, and of greater moment, is the risk we run of fatiguing and straining the accommodative power of the eyes, and so causing weak sight.

OLD SIGHT DOES NOT MEAN OLD AGE.

In these days of weak sight and eye-glasses

there need be no fear that the adoption of glasses will be interpreted as a confession of old age. Old sight comes very early—much earlier than forty—in most over-sighted eyes, and this flat formation of the eye is more common than any other. I have had to prescribe, now and then, glasses for youth as strong as those usually worn by people sixty and seventy years old. Frequently, even in the best-formed eyes, ill-health, nervous debility, or a constant and severe use of the vision in fine work or night work, will develop the symptoms of old sight as early as the age of twenty-five or thirty. All things being equal, a farmer, if he is not studious, may postpone the use of glasses longer than a professional or literary person, or anyone who reads a great deal. Nothing, however, is gained by postponement: the eyes are not made stronger, and are likely to be made weaker. But if we take the age of forty or forty-five as the average age for the beginning of old sight, it can by no means be considered as the beginning of old age and the intellectual decline that marks its reign. Most men and women do the serious and best work of their lives after the age of forty, and some even after the age of sixty.

Very rapid growth of old sight, requiring a frequent change to stronger and stronger glasses at short intervals, indicates the beginning of a serious

disease of the eye, incident to middle and old age, called Glaucoma.

PECULIAR SIGHT (ASTIGMATISM).

This visual defect may be recognized by looking at vertical and horizontal lines, and comparing their blackness and distinctness at different distances. The letters N and Z on the frontispiece are made up of horizontal and vertical lines. If at any distance from ten to twenty feet one letter appears less clear than the other, there is an inability of the eye to see vertical and horizontal lines equally well. The larger lines may be tried in the same way at from twenty to forty feet. A more complete test than either is perhaps a diagram with lines radiating from the centre like the spokes of a wheel. If any of the spokes appear indistinct or wanting (all being drawn of equal size and blackness), there is defective sight. This defect is, of course, a great hindrance to clear and easy vision in reading, as letters are made up of lines running in different directions.

CAUSE AND CURE OF PECULIAR SIGHT.

This curious defect is due, generally, to a want of symmetry—that is, a want of smoothness, evenness, or roundness of form—in the convex front of the eye-ball. Usually it dates from birth, although

it may not be troublesome enough to attract attention until the eyes are put to considerable use in study, reading, or like occupations.

The cure is in the scientific adaptation of spectacles, or glasses, that neutralize the effect of the imperfect shape of the convex front of the eye. The glasses are peculiarly ground to fit the individual case; and it is perhaps needless to add that the common convex and concave glasses can be of no important help. Indeed, one may always suspect this kind of sight when informed that "no glasses seem to fit," or to give the desired clearness of vision. A good oculist should be consulted, who will see that glasses are properly ground and fitted. The relief to the eyes in reading and sewing which follows properly fitting glasses is very remarkable. A patient of mine had for years suffered from weak sight, weak eyes, inflamed eye-lids, headache, and depression, and had tried all kinds of relief but the right kind. Properly fitting glasses gave her good sight; and as a consequence of this her other ills were banished.

IMMUNITY FROM WEAK SIGHT.

It is probably understood by the reader, from what has been said, that weak sight is very often due to defective form of the eye-ball. It is too flat, too full, or of irregular form. This makes

vision an effort for both far and near, and sooner or later the result is weak sight. Now, the large majority of eyes are more or less imperfect in form; hence the prevalence of visual weakness. General ill-health may also account for some of the inability to use the eyes. There are, however, some people who appear to have eyes nearly perfect in form, and, having also a large power of accommodation, are able to see fine and near objects, as well as distant ones, with slight effort. Such persons can be very careless of their sight; can read in the steam-cars by night or day, in fact neglect all the nice rules and regulations that I have given. But such individuals are not common. Many persons think they have such eyes until they put them to severe use.

SPECTACLES AND EYE-GLASSES.

For elderly people who wear glasses to correct old sight, spectacles are usually preferred to eye-glasses. Still, for occasional use, eye-glasses, suspended around the neck by a cord, are always at hand, and quickly adjusted upon the nose. For long sessions of reading, writing, or sewing, spectacles are more comfortable; but as being exceedingly liable to get misplaced, it is well to have a pair of eye-glasses to fill inconvenient gaps. For weak sight, eye-glasses are generally preferable, as

such eyes cannot be used continuously, and the use of glasses being compulsory, it is wiser to have them always at hand.

COLOURED GLASSES.

Either blue or smoke-coloured glasses are useful in weak sight, if there is great dread of light. But unless really necessary, it is better not to wear them, as the eye may become so habituated to a subdued light as to be intolerant of ordinary daylight. They may be worn profitably, if needed, in bright sunlight on the snow, sand, or water. When the dread of light is great, one may also procure glasses of the proper number, convex or concave, for over-sight or near-sight, slightly blue-tinted, so as to soften the glare of the white page in reading. Coloured glasses for reading should not be too dark in tint, lest it require too much exertion to see clearly through them.

COLOUR-BLINDNESS.

Recent investigations appear to show that about twenty-five men in every hundred are more or less colour-blind: they cannot distinguish red from green. As these are the colours employed on railways to signal danger and the reverse, it would appear that somebody in authority should take care that locomotive-engineers are free from colour-blindness.



CONTAGIOUS DISEASES OF THE EYE.

Diseases of the eye or eye-lids, characterized by a discharge more or less thick, purulent, or mucus-like, are contagious. If the discharge from eyes thus affected comes in contact with a healthy eye, it may cause in it a similar disease. Those suffering from disease of this nature should therefore be kept isolated as much as possible, in order to lessen the chances of communicating it to others. Children, and especially infants, frequently suffer from these affections, and great caution and cleanliness are required to prevent contagion. Towels and napkins should not be used in common; and the more freely water is used the better, as the most poisonous discharge of this kind is rendered harmless if mixed with fifty or a hundred times its volume of water. It should also be mentioned, in this connection, that a discharge from other parts of the body, of a purulent nature, if it happen through inadvertence to come in contact with the eye, may give rise to a disease so severe as to endanger the sight.

ORDINARY ACCIDENTS TO THE EYES.

Workers in places where splinters of metal, stone, or wood are liable to strike the eye should wear spectacles at their work, with strong plane glasses in them. Plane glasses are also an efficient protection in railway travelling against the common

accident of a spark or cinder in the eye. Riding backwards, when it can be tolerated, is also a safeguard against cinders and dust.

A CINDER IN THE EYE.

Having caught a cinder in the eye, it is possible that, by remaining quiet a while, it may be dissolved by the tears, and vanish ; or we may promote the flow of tears by attempting to open the eye now and then, and cause the cinder to be carried off by them. We may also help the flow of tears by seizing the edge of the upper lid, drawing it away from the eye-ball, and at the same time blowing the nose smartly. Or we may pull the upper lid down over the edge of the lower, and, thrusting the latter up beneath it, make the lower eye-lashes do service as a broom in brushing away the offending substance. If these expedients fail, we have a sure one in turning over the upper lid and wiping off the cinder. This is easily done by a travelling companion. Take a pencil-case for a fulcrum ; place it parallel with the edge of the upper lid about half an inch above it; then, with the thumb and finger of the other hand, seize the upper lid firmly by its eye-lashes and free edge, direct the person to look down, and, the moment the eye-ball rolls downward, turn the lid quickly up over the pencil. Do not wipe the delicate surface

of the everted lid with the handkerchief more than is necessary. First find the situation of the offending substance,—which possibly may be so small as to be almost invisible ; then remove it with the finger or the point of the pencil, or with the handkerchief turned over the end of the finger. The cinder will generally be found at about the middle of the upper lid, not far back from the edge.

FOREIGN BODY ON THE BALL OF THE EYE.

In case the foreign body sticks on the ball of the eye in front of the pupil, it may be wiped off with a bit of paper twisted to a point, or possibly by a bit of soft-pine wood (say the free end of a common friction-match). If, however, it does not come off easily, surgical aid must be sought, as great harm may be done to the transparent front of the eye by the use of sharp instruments in inexperienced hands.

QUICK-LIME OR MORTAR IN THE EYE.

When either of the above substances has fallen into the eye, it is best to drop some sweet oil in as soon as possible. The eye may then be syringed out with warm water, to wash away all the particles of lime possible. If the eye is injured from a strong acid, use milk and water at once in the same way. These are the best expedients pending the arrival of the oculist or surgeon,

BIT OF PERCUSSION-CAP IN THE EYE.

A bit of exploded percussion-cap entering the eye is usually fatal to the injured organ. Children are fond of exploding caps with a hammer or stone. It is an extremely dangerous pastime ; and an eye being struck, an oculist should be at once consulted, as there is danger, not only of the loss of the eye, but, if certain unfavourable symptoms are neglected, of the loss of the other uninjured eye as well.

SYMPATHETIC DISEASE OF THE UNINJURED EYE.

This may occur if a wound in the fellow-eye is very serious, or if a bit of metal has lodged within it. It is imperative therefore in these cases to seek competent advice, not wholly for the sake of the injured eye, but to save the sound eye also. To save the uninjured eye, it is sometimes advisable to have the injured eye removed, so as to prevent the spread of the inflammation to the sound one and avert blindness.

ARTIFICIAL EYES.

An artificial or glass eye is a thin shell of glass or porcelain, made to fit over the stump or remains of an eye that has been removed, or has been lost by disease. It is painted in imitation of the natural eye, and in favourable cases is easily mistaken for it

across the room. It is usually inserted in the morning by the wearer, and removed at night ; and when charlatans advertise that they insert artificial eyes without pain, they only promise to do what every wearer of a glass eye does for himself every day.

THE EYES OF CHILDREN.

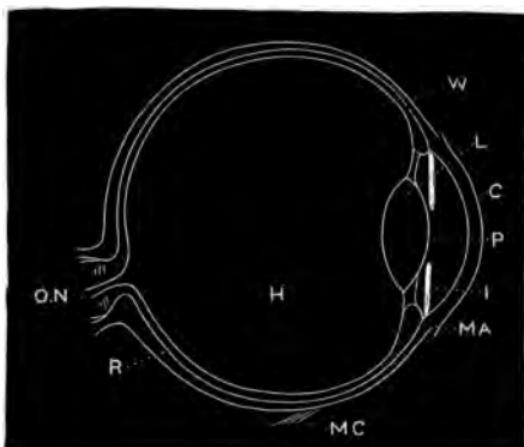
New-born babies are subject to a dangerous inflammation of the eyes, coming on two or three days after birth. There is great swelling of the eyelids, and later a copious discharge of matter from the eyes. This discharge is contagious, and coming in contact with healthy eyes, may give rise in them to a similar disease. Great care should be taken therefore to keep the child apart from others, and the greatest cleanliness should be provided for. The affected eye or eyes should be syringed out every hour with warm water, so that the poisonous matter may be removed as soon as formed. When severe, this affection is very dangerous to the sight, and therefore the best medical aid—an oculist, if possible—should be summoned without delay.

CATARACT IN CHILDREN.

When children are observed to avoid a bright light in reading and study, and are noticed to hold the book more or less at one side, as well as very

near the eyes, it probably will be found that they have cataracts. A cataract is an opacity of the lens, L in Fig. A below. This lens in health is quite transparent like glass, but in cataract it becomes opaque and unclear, somewhat like ground glass. The centre of the lens, right behind the

FIG. A.



middle of the pupil (P), is generally the most opaque. The pupil (which is the hole in the iris) has, as is generally known, the power of enlarging in a dim light, and of growing smaller in a bright light. The larger this hole or pupil, the better the child with cataract sees; and therefore a dim light is preferred for reading. If the opaquest part of the

lens is not exactly in the centre, but more at one side, then the print will be read more easily by holding the book slightly at the other side of the eye. And always the book must be held quite near, to aid the eye in its difficult task of seeing through an unclear lens.

By looking at the figure, it will be seen also that any spot on the transparent front of the eye (C) that covers the pupil and iris (I)—very much as a watch-glass covers the face of a watch—would also make sight imperfect and difficult. But if the front of the eye and lens are clear and the pupil open, the eye being well formed, a loss of sight must be due to disease in the back of the eye,—in the retina (R) and its adjacent tissues,—or else the optic nerve (O N) for some reason fails to carry the impression of sight in the eye to the brain.

WHAT TO DO FOR CATARACT IN CHILDREN.

In these cases an oculist should be seen in order to determine whether it be cataract, or near-sight, or some other affection. If cataract, then he will advise its removal; or, if small or at one side, perhaps the making of an artificial pupil instead. As an eye covered by a cataract gradually loses its visual power through want of exercise of the sight, advice in these cases should be sought during the early life of the child.

OVER-SIGHT A CAUSE OF SQUINT OR CROSS-EYE.

The defect of sight called over-sight, the opposite of near-sight, is sufficiently explained at page 20. It is sometimes the cause of weak sight in children, and is then to be treated as directed on pages 58, 59. It is also the usual cause of a turning inward of one or both eyes, constituting squint or cross-eye. In the beginning of this squint, if the child is old enough to be fitted with proper convex glasses, the affection may be cured by thus curing the over-sight. But if the trouble is one of years' standing, it should be cured by a surgical operation. Go to a good oculist, and he will cut the muscle of convergence (M C in the figure, p. 48), and this will restore the eye to its proper position.

PROGRESSIVE NEAR-SIGHT IN CHILDREN.

Near-sight in children is noticed usually at about the age of seven or eight or earlier, if the tendency is inherited; and from this age up to that of fifteen or sixteen, if acquired. It is probably very often acquired, oftener than is generally supposed; at least, it is often observed when neither parents nor relatives, so far as can be learned, are similarly affected. Too much study, too much school, too continuous use of the eyes on near objects, too little out-door life and exercise of the eyes in

distant vision,—these are, possibly, sufficient to cause near-sight, without hereditary influence.

SYMPTOMS OF NEAR-SIGHT IN CHILDREN.

The symptoms are similar to those mentioned on page 28 and the following pages. At school the children fail to see the figures on the blackboard across the room, and in study they hold the book nearer than others. Such eyes are not able to see the letters numbered 20 at twenty feet and 50 at fifty feet distance. They are not able to read the type below at a distance of twenty-four inches. One with correctly formed eyes can do this without unusual effort.

EXTRACT FROM PROF. HUXLEY.

"The educational abomination of desolation of the present day is the stimulation of young people to work at high pressure by incessant competitive examinations. Some wise man (who probably was not an early riser) has said of early risers in general, that they are conceited all the forenoon and stupid all the afternoon. Now, whether this is true of early risers in the common acceptation of the word or not, I will not pretend to say; but it is too often true of the unhappy children who are forced to rise too early in their classes. They are conceited all the forenoon of life, and stupid all its afternoon. The vigour and freshness which should have been stored up for the purposes of the hard struggle for existence in practical life have been washed out of them by precocious mental debauchery,—by book-gluttony and lesson-bibbing. Their faculties are worn out by the strain put upon their callow brains, and they are demoralized by worthless childish triumphs before the real work of life begins. I have no compassion for sloth, but youth has more need for intellectual rest than age; and the cheerfulness, the tenacity of purpose, the power of work which make many a successful man what he is, must often be placed to the credit, not of his hours of industry, but to that of his hours of idleness, in boyhood. Even the hardest worker of us all, if he has to deal with anything above mere details, will do well, now and again, to let his brain lie fallow for a space. The next crop of thought will certainly be all the fuller in the ear, and the weeds fewer."

But there are other symptoms of near-sight, of a general nature. One of the most common is a frontal headache, or headache over the eyes. This is a very usual symptom of near-sight in school-children, and it is frequently accompanied by a sense of languor and fatigue, and of an indisposition for active bodily exertion. In fact, the progressive, acquired near-sight almost invariably comes in the weakly, ill-nourished, studious, precocious child. And this general weakness and ill-health favours the rise and progress of the disease at the back of the eye, to be considered later.

HOW NEAR-SIGHT IS ACQUIRED BY CHILDREN.

It will be remembered that in this defect the eye-ball (as seen in Fig. F, p. 29) is too long ; that the refractive or focussing power of the eye, therefore, brings the rays of light to a point before they reach the retina. A tendency to near-sight, or even a deficient light without the tendency, forces the child to hold the book rather near, and this requires the turning inward or convergence of the eyes so that both may be brought to bear upon the same point of vision. Now, a studious boy or girl of ten or fifteen years, besides the five or six hours' work in school, studies also more or less at home, while the leisure hours are spent over novels or books of travel. In short, the eyes are not only

used nearly continuously in regarding near objects, but their use for distance is almost wholly neglected. It is not surprising that, under such training, an organ should lose some portion of its functional power. It is to be remembered that in youth the tissues of the eye are soft, yielding, and undeveloped ; that it is a growing organ, easily moulded ; that its future, like other parts of the body, is to be very much what it is made by training, use, and abuse. When we regard near objects, there is the action of the accommodative power, the convergence, the movement of the pupil and the adjacent tissues, and a forward movement of the whole eye-ball. All this is muscular exercise ; and whether this exercise is kept up all through the day or not cannot be a matter of indifference to an immature and growing eye. It is supposed—and very reasonably, I think—that the muscular pressure upon the yielding eye-ball, and especially the pressure in turning the eyes inward, promotes indirectly a bulging of the eye at the back, and so contributes to the progress of near-sight.

But whatever difference of opinion may exist as to the exact way in which near-sight is made to increase, there is no question as to the fact ; and it is especially true that the acquired near-sight of youth is progressive, and sometimes rapidly so. School statistics, made ten years ago and verified

again and again since, have shown that it progresses with the age of the pupil and the increased demand upon the eyes. That is, in the elementary schools there are fewer, and in the higher schools more, near-sighted ; and the grade of the defect is also more severe as we reach the high-school and college.

PROGRESSIVE NEAR-SIGHT IN CHILDREN A DISEASE.

This affection is, as I have remarked, not merely an optical defect, but is almost invariably a disease as well. The elongation of the eye-ball in near-sight is at the back, and of course, as the outer or protective coat of the eye is stretched, the two inner tissues (the vascular and nervous coats) are unnaturally distended also. The inner tissues do not bear this distension well : they become thinned, congested, inflamed, degenerated, and finally are partially lost over a limited portion of the interior of the eye near the entrance of the optic nerve. When we look into such eyes with the ophthalmoscope, we see at this diseased part, not the retina and the middle or vascular coat as in the healthy eye, but the outer covering, the glistening white-of-the-eye, shining through these attenuated tissues. In such cases, the white-of-the-eye is visible both inside and outside. The instrument that we use to

look into an eye, called an ophthalmoscope, is merely a small mirror with which to throw light into the eye. It has a hole through its centre for the observer, so that he may look straight at the part of the interior of the eye that is lighted up. Simple as it is and much as it had been needed, the ophthalmoscope was not invented until after the year 1850.

It seems almost needless to say that an affection at the back of the eye, capable of destroying its tissues, may if neglected lead to blindness. Every oculist is sought now and then for advice in regard to an eye blind from neglected myopia. Vision from this cause is however not often lost before adult age,—usually between the age of thirty and forty-five perhaps. Fortunately, the destruction of the tissues, under abuse of the eyes in progressive myopia, does not advance with equal rapidity in both eyes; so that if sight be lost in one, the sufferer is quite sure to adopt every means for its preservation in the other. It is clear therefore that a myopic eye is not, as is frequently supposed, a strong eye, but on the contrary a weak one; or at least liable to become, if abused, a weak one. It is true that inherited myopic eyes are sometimes strong, but the greater number are nevertheless weak and diseased. *Acquired* myopia almost invariably threatens the integrity of the eye and its

functions. The pain in the head and eyes spoken of is not necessarily due to disease, but may come chiefly from a muscular fatigue owing to the strain upon the muscles of convergence and accommodation, or from a want of proper co-ordination between them.

THE SCHOOL-ROOM.

There is no doubt that deficient and improperly admitted light in school-rooms is one cause of the rapid progress of this optical defect. To sit facing a light during study, for instance, is extremely injurious to the best eyes. On looking up, the eye becomes saturated with light, and then, on turning to the printed page, an extra accommodative effort must be made to overcome the dazzling and clear up the vision. The light should enter from above and at the side, so as to strike the page of the book and not the eyes ; and it should be if possible a direct rather than a reflected light.

A deficient illumination is injurious because it requires the book to be brought near the eye, and this, as we have seen, tends to pressure on the eye-ball from the muscle of convergence and the other external muscles that control its movements ; and so indirectly promotes the posterior bulging that we have already noticed.

School furniture is also often ill adapted for the

scholar, even if properly placed as regards light. The bench is too high for the desk, so that the pupil must bend over his work; thus favouring congestion to the head, and contributing to the congested condition at the back of the eyes; or the seat is too far away from the desk, and the head is therefore brought too near the book, so that the growth of near-sight is directly encouraged.

All these school-room imperfections might, of course, be of comparatively inferior moment, if it were not for the fact that children are obliged to spend six hours a day in school for nearly the whole year round. If the high-pressure system of education shall be succeeded in course of time by a system more rational, moderate, and healthful, the interior arrangements of the school-houses will not be so serious a matter. Any middle-aged person can look back to the days when near-sight and weak sight among boys and girls were quite rare. It was not then the fashion to teach children everything,—including drawing, music, and all the languages except English. Nor was it then supposed that a sufficient amount of bodily exercise would neutralize the effect of an excessive amount of brain-work. Two and two then made four, and the brilliant notion that an exhaustion in one direction could be made good by an exhaustion in another direction was not then in vogue.

WHAT SHOULD BE DONE FOR PROGRESSIVE NEAR-SIGHT IN CHILDREN.

The first and best thing to do is to take them from school, stop their reading and all use of the eyes for near objects as far as practicable, and see that they use their eyes for distance. Encourage them to climb the hills and look miles and miles away. I remember a boy of twelve in whose case the above advice was fully carried out, and in less than one month his power of vision for distant objects had doubled. On leaving school, he saw across the room no smaller letters than those the size of the largest at page 25 ; but in less than one month he could see at the same distance the smaller ones numbered 20. The quick improvement in sight for distant objects brought about by the method above described is surprising.

After a time,—perhaps from three or six months to a year,—the improvement in vision for distance will cease ; and then, if the general health warrants it, proper glasses should be selected by an oculist, and the studies, under his direction, may be resumed. But always and continually in this affection care must be taken that children do not become too studious and sedentary ; that they be encouraged to play out of doors, and above all to use their eyes daily in regarding distant objects.

When there is much disease at the back of the eye, it is advisable of course to keep them under proper medical supervision ; and always, in the case of children, a near-sighted eye should be examined by a competent ophthalmoscopist, to determine whether active disease be present or not.

IMPERFECTION OF THE EYE AS AN OPTICAL INSTRUMENT.

We have already noticed the optical imperfections of the near-sighted, old-sighted, over-sighted, and peculiar-sighted eye ; and it remains now to be said that all eyes, including such as are considered perfect, are, optically considered, far from perfect. These faults, unlike those already spoken of, are irremediable, and are chiefly as follows :—

1. There is a want of transparency in the cornea (C, Fig. A) and the lens (L, Fig. A), and fluorescence of both. Fluorescence is the property that certain substances have of becoming faintly luminous from blue or violet light. The bluish tint of a solution of quinine in water is an example of fluorescence. A blue light thrown into the eye shows a haziness of both cornea and lens. These parts of the eye are therefore inferior to the clear and transparent lenses used by opticians in the manufacture of optical instruments.

2. Spherical aberration, due to a lack of corre-

sponding symmetry in the cornea and lens, or to a lack of correspondence in their axes. This makes the refractive power of the two inharmonious, creating a slight astigmatism (see p. 39). The traditional figure of a star has five points. The eye sees a star with more or less luminous points, when, if it were optically perfect, it would see it as it is ; that is, without the points.

3. Achromatism, or chromatic dispersion of rays. The solar rays being made up of the different colours of the spectrum, and each colour being refracted in a different degree by the same medium, they are not united by it in a single focus. Look at a street lamp at a distance through a violet-coloured glass. This stops the intermediate green and yellow rays, and allows the first and last rays—the violet or blue and the red—to pass into the eye. The result is that the red is focussed, but the violet and the blue are seen in a broad halo around the red gas-light. Optical instruments are free from this defect.

4. Slight colour-blindness is common to all eyes. The eccentric portion of the retina, or that part away from the centre, does not perceive red as soon as other colours. If we test the field of vision by fixing one eye on something directly in front of it, and, keeping it fixed, move a red object across the field of vision from one side to the other, we shall

find that the *colour* of a red object is not recognizable as far away from the centre of the visual field as the *outline* of it. The eye also fails to distinguish a difference between a white produced by the union of scarlet and bluish-green light and a white made by yellowish-green and violet ; yet the first comes out black in a photograph, the latter very bright.

5. There is a blind spot on the retina of every eye, due to the space occupied by the entrance of the optic nerve. If we make a small cross on a sheet of paper, and three inches at the right of this a black dot, then close the left eye, hold the paper at arm's length, fix the right eye on the cross,—it will be found, on bringing the paper nearer, that at about eleven inches from the eye the dot will not be seen. The blind spot is large enough to hide the face of a man at six or seven feet distance.

6. The yellow spot—the centre and most sensitive point of the retina—is by virtue of its yellow tint unable to recognize weak blue light. The smaller stars are seen better by astronomers if they look slightly at one side rather than directly towards them.

This formidable array of common optical defects is unnoticed by us, chiefly because, having two eyes in almost constant motion, one makes up for the temporary visual disturbance in the other.

Even with one eye, these defects are rarely noticed, owing to the great mobility of the eye and its continuous change in direction, and to the fact that the imperfections are mostly away from the centre of the field of vision. Habit, inattention, experience, the power of accommodation, may also be given as reasons why our natural visual defects are mostly unobserved. Nevertheless, these optical defects do exist in all eyes ; and, as Professor Helmholtz remarks, if an optician offered for sale an instrument with these faults, one would be justified in refusing to buy it.

(4 TO 4½ FEET.)

THIS print should be read with ease, in a good light, by what is called a perfect eye, at the distance stated above. No eye, as we have seen, is however really perfect. But if no optical defects serious enough to occasion inconvenience, or to call for the use of glasses to distinguish distant objects clearly, are present, the eye may be called perfect. Nevertheless, a slight and perhaps unno-

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ticed defect may, under certain circumstances, by making a too-continuous use of the accommodative power necessary,

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weak sight sometimes, even if the eye be nearly correct in form and refraction.

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ANIMALS.—*See* Lankester (E.).
ANTIQUARIAN.—*See* Jewitt, Walford.
AQUARIUM.—*See* Science Gossip, Taylor.
ARCHITECTURE.—*See* Vincent.
ART.—*See* Bayliss, Heaphy, Zerffi.
ASTRONOMY.—*See* Darby, Popular Science Review, Proctor.
ATHLETIC TRAINING.—*See* Michod.
BEES.—*See* Hunter, Jardine.
BIRDS.—*See* Ornithology.
BOTANY.—*See* Carrington, Cooke, De Crespigny, Economic, Edgeworth, Gatty, Hooker, Lankester (Mrs.), London, Lowe, Midland Naturalist, Nave, Notes on Collecting, Popular Science Review, Robson, Schleiden, Science Gossip, Smith (J.), Smith (W.), Sowerby, Spicer, Taylor, Trimen, Tripp, Wooster.
CHEMISTRY.—*See* Brande and Taylor, Popular Science Review.
CHILDREN.—*See* Barker.
CONCHOLOGY.—*See* Conchology (Journal of), Notes on Collecting, Tate.
CRUIKSHANK (GEORGE).—*See* Chamisso.
- DOGS.—*See* Smith (C. H.).
ENTOMOLOGY.—*See* Duncan, Midland Naturalist, Mortis, Naturalist's Library, Newman, Notes on Collecting, Science Gossip.
EYE (THE).—*See* Dudgeon.
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FISH.—*See* Ichthyology.
FOLK-LORE.—*See* Dyer.
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FRENCH LANGUAGE.—*See* Blin-court.
GENEALOGY.—*See* Walford.
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ICHTHYOLOGY.—*See* Bushnan, Capel, Couch, Hamilton, Jardine, Naturalist's Library, Schomburgk, Science Gossip.

Index of Subjects.

- | | |
|---|---|
| <p>INSECTS.—<i>See Entomology.</i></p> <p>KNOTS.—<i>See Book of Knots.</i></p> <p>LAW.—<i>See Forbes, Geach.</i></p> <p>MAN.—<i>See Sharpe, Smith (C. H.)</i></p> <p>MEDICINE &c.—<i>See Dewar, Fleischmann, Granville, Parkin, Schaible.</i></p> <p>MICROSCOPY.—<i>See Cooke, Davies, Edwards, How to Choose, Lankester, Midland Naturalist, Nave, Phin, Popular Science Review, Quckert, Schmidt, Science Gossip.</i></p> <p>MINERALOGY.—<i>See Popular Science Review.</i></p> <p>NATURAL SCIENCE.—<i>See Barnard.</i></p> <p>NEEDLE-WORK.—<i>See Trotter.</i></p> <p>OOLOGY.—<i>See Morris, Notes on Collecting.</i></p> <p>ORNITHOLOGY.—<i>See Bree, Jardine, Martin, Morris, Naturalist's Library, Science Gossip, Selby, Swainson, Wilson.</i></p> <p>PHOTOGRAPHY.—<i>See Monk-hoven, Russell.</i></p> <p>PHYSICS.—<i>See Popular Science Review.</i></p> <p>PHYSIOLOGY.—<i>See Lankester.</i></p> | <p>POETRY.—<i>See Baddeley, Barclay, Bennoch, Changed Cross, Crown of Life, Crawley, Forsayth, Idyls, Sharpe.</i></p> <p>PROFESSIONS.—<i>See Pascoe.</i></p> <p>REPTILES.—<i>See Cooke.</i></p> <p>SCIENCE MADE EASY.—<i>See Twining.</i></p> <p>SHOOTING.—<i>See How to Use, Shooting.</i></p> <p>SPIRITUALISM.—<i>See Zerffi.</i></p> <p>SPORTING.—<i>See Rooper.</i></p> <p>THAMES (THE).—<i>See Up the River.</i></p> <p>TOBACCO.—<i>See Steinmetz.</i></p> <p>TRAVELLERS (HINTS FOR).—<i>See Boner, Lord.</i></p> <p>WATCHES AND CLOCKS.—<i>See Benson.</i></p> <p>WILD FLOWERS.—<i>See Lankester (Mrs.)</i></p> <p>WINDS AND TIDES.—<i>See Jordan.</i></p> <p>WOMAN.—<i>See Cresswell.</i></p> <p>ZOOLOGY.—<i>See Hamilton, Jardine, Macgillivray, Midland Naturalist, Mivart, Naturalist's Library, Popular Science Review, Science Gossip, Smith (C.), Taylor, Waterhouse.</i></p> |
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